# IllinoisTechnograph



## Boomerangs Return

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# IllinoisTechnograph

Celebrating 100 years of publication

*On the cover: National champion boomerang thrower Paul Sprague demonstrates the flight of a boomerang. The ancient sport of 'ranging has recently found returning popularity (photo by Dave Colburn).*




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# Tech Teasers

**1.** Two animals of the feline species are on opposite sides of a steeply slanted roof and are about to fall off. Which one will endure the longest?

**2.** The middle pearl on a string of 33 is the largest and best of all. The others are selected and arranged so that, starting from one end, each successive pearl is worth $100 more than the preceding one. From the other end, the pearls increase in value by $150 up to the large pearl. The entire strand is worth $65,000. What is the value of the large pearl?

**3.** After a particularly severe mid-term exam, several students dropped the class. The number of people who dropped was equal to the square root of half the number of people in the class originally. Of the original people in the class, 8/9 are sitting in the lecture room diligently taking notes. Two students are blowing off class to play frisbee on the quad. How many people were initially on the class roster?

**4.** An eccentric millionaire's will stipulated that his fortune of exactly $1,000,000 should be divided among his 16 Lhasa Apsos as follows: every gift must be either $1 or a power of $7, and no more than six dogs can receive the same amount. How was the money apportioned?

**5.** Poindexter, a creative engineering student, devised a scheme to revolutionize the business world. "I can take 4 from 4 and leave 8," he said. "That's impossible!" replied Biff, a business major who had survived the rigors of Math 111 and who knew that his friend couldn't be right. How did Poindexter prove his point?

**Answers on page 12**

# Editorial

**From Start to Finish**

***Are you ready for a technical challenge?***

"Man, I wanna be in second grade."

"Whatever for? How can you *say* that?"

"Well, back then I had a set schedule. I'd come home from school, go out and mess around until dinner, watch some TV, go to bed, and then do it again."

"You really want to be there again now? Besides, once you graduate you'll be able to have a set schedule again."

***Picture yourself in a world-wide company with emphasis on the individual***

"It's gonna be so cool! I'll get a house, a car, a piano, an excellent stereo. . .and I'll eat really good food for once!"

"Yeah, but you only need cigarettes and ice to live."

"So you say, but I don't see you turning down large plates of stroganoff for cigarettes."

***For a career that can't be duplicated, work with an original***

"So how'd the interview go?"

"I dunno. Pretty bad, I think."

"How come? What happened? You prepared for it a lot!"

"I don't know. . .I study up for an interview, eat right, take vitamins, talk a lot about who I am, what I want, and what I can offer, and it gets me nothing but a callous bong letter. Then, if I walk cold into an interview after only about three hours sleep and with an apathetic attitude, they offer a plant trip right there. Pretty weird."

***Your first 18 months. . .can make the past 4 years pay off***

"I had a lousy interview today. I also decided I'm addicted to caffeine."

"I bet you didn't have a good breakfast to start out your day right."

"No. I had a bottle of pop. I can't be my usual jovial and entertaining self in the morning for someone I don't know unless I have caffeine first."

"Yeah, I understand. I wonder what would happen if you had a few beers before an interview?"

***If you thrive on responsibility, the opportunity is here!***

"I don't want to graduate. I'll have to go to a new place with nothing and slowly build my life and credit up, so that when I'm too old to enjoy life I'll have lots of money and materialistic joys."

"Really. Why don't we, as society, give *everything* to the young and take it away gradually so that when you retire you have nothing? I mean, I'd have a lot more fun with a million dollars now than I would in 50 years."

***The people behind advanced missile engineering seek perfection***

"You know what's really scary to think about?"

"What's that?"

"Kid's shoes."

"Yeah. Look man, I gotta go. . ."

"No, seriously. Think about buying shoes for your kid that you and your wife have brought up together. You gotta get shoes for it that it will grow up in. Don't you think that's scary?"

***Imagine the career you want***

"I think we should post all our bong letters on the wall."

"Why? Everyone does that. It's kinda silly. Besides, I'd be embarrassed."

"But then we would have a physical projection of our bitterness and unyielding hope, displayed in a quasi-artistical form. Besides, all those companies' letterheads look cool."

***Rising professionals—career advancements are within your reach***

"Do you think they have fun in the real world?"

"Nah."

***From finish. . .to start***

# What Makes a Good T.A.?

**Special talents are required of teaching assistants to convey their knowledge and experiences to students.**

Attending any Big Ten school can mean that students will often learn from teaching assistants in addition to or in place of professors. Although this may not be a drawback, both good and bad teaching assistants exist just as good and bad professors do.

The University does not always obtain ideal teaching assistants, which is a situation, according to Professor H. G. Friedman of the computer science department, that is "inescapable." If all teaching assistants are not created equal, then what makes one teaching assistant better than another?

Finding teaching assistants encompasses a search similar to that of finding employees for any job. Ads are distributed through national outlets, applications are received, and the most qualified applicants are finally chosen. Friedman explained that although the knowledge and intellect of the teaching assistant may be perceivable from the application, a good teaching assistant has an "undefinable talent that only students can tell." This talent includes a sensitivity to the students' needs and desires.

Professor Sylvian Ray, also of the computer science department, further explained that the humanitarian aspects of the individual cannot always be seen in new people, creating a sad problem. Although this makes it difficult to find the ideal teaching assistant, most applicants are found acceptable and, once hired, are rarely disposed of.

Ray believes that a good teaching assistant must interact well with students. "There is a fine line of decision between knowing when to take charge of the situation and knowing what is sensible in terms of how the instructor wants to run the course," he said. For Ray, the key aspect of a qualified teaching assistant is a balance of trying to obey the professor, accepting the general philosophy of the course, and using some initiative of his own. According to Ray, a good teaching assistant will possess "an attitude of noblesse oblige with respect to the students." A teaching assistant who displays egotism by cutting down others who are less knowledgeable than he, or one who is not helpful toward the students, is the opposite of what Ray prefers to see. He further explained that teaching assistants should not show off how much they know but rather have a general attitude of mercy toward the students. On the more technical side, a teaching assistant should know the subject well and be able to explain it clearly. "It is when the humanities part and the technicalities part balance nicely that makes a super teaching assistant," he said.

According to mathematics professor Wilson M. Zaring, "a good teaching assistant has two different jobs—one to teach and the other to study." Teaching includes certain intangibles such as an outgoing personality, interest in others, and a motivation to teach. As a student, Zaring feels that a teaching assistant should also have "a proper background, intelligence, drive, motivation, and desire." There have been teaching assistants in the past which have not worked out either academically or as a teacher. They either lack the ability to communicate or don't prepare for teaching their class. Zaring feels that if the teaching assistant does not have a feel for what the students want, he is not a good teaching assistant and never will be. "The issue of success has to do with drive, motivation, and ability," said Zaring.

Teaching, to Friedman, runs in a circle like all other skills. "If you like teaching you're better at it, and if you're better at it you like it more," he explained. Friedman feels that a good teaching assistant should "have the ability to communicate—he should know the subject and have a good command of the English language." However, he pointed out, this does not include all American teaching assistants and does not exclude all foreign teaching assistants.

Zaring added to this with one experience of hiring a teaching assistant. A student applied to become a teaching assistant, but because his English was marginal, Zaring was hesitant in hiring him. He explained to the teaching prospect that students tend to have a negative reaction to accents. The prospect understood, but still wanted to teach. He told the professor this and also that he would write everything out, pass out handouts, and speak slowly. Because the motivation and desire to succeed were largely present, the prospective teaching assistant was hired and eventually generated a positive response from the students. Zaring believes that this particular teaching assistant went over well because he wanted to succeed and, because of this strong desire, made an extra effort.

Amra Serdarevic, a teaching assistant for Physics 106, explained that being a teaching assistant is not an easy job and requires a lot of time. A good teaching assistant will find this time and use it to prepare for class, grade the students' work, conduct office hours, and have time for students outside office hours. She felt that the students should be told what is expected of them with an attitude of wanting to teach them something, rather than punishing them for not doing things.

Jenny Karloski, a teaching assistant for Chemistry 102, has a positive attitude about teaching. She explained that a good teaching assistant should care about the students and be willing to take time with them. Two other important factors are that the

Caroline Kurita

teaching assistant should know what he is talking about and be able to present the material in an organized fashion.

Being prepared and writing clearly are just some of the qualities that Jerry Scappaticci, a Math 242 teaching assistant, considers important. He also feels that using homework to check the students' understanding of the material, grading fairly, and being considerate of the students are important.

"In order to be a teacher, you have to want people to learn and be excited about learning," said Lu Ann Duffus, a teaching assistant for Economics 101. She stressed that the key word necessary to be a good teaching assistant is enthusiasm. "If you're not enthusiastic, you can't expect the class to be." Even if a teaching assistant is not partial to a certain section, enthusiasm must be developed in order to teach it well, she explained. Just because a person is knowledgeable, he is not necessarily a good teacher.

Kim Kerry, a Chemistry 102P teaching assistant, felt that there are basically two different responsibilities of a good teaching assistant. One is to teach something by covering the required material, and the other is to give the students something they can swallow. The teaching assistant must find out what the students know and don't know, as well as what they expect to learn. She explained that the material should be presented clearly and questions should be answered. A good teaching assistant should care about whether the students are doing well or not, rather than just go through their papers.

Dennis Youn, a teaching assistant for Chemistry 102 lab, explained that the job of teaching for lab work is less difficult than for a discussion section. His role is to explain the technical problems of the lab and to give quizzes. A good teaching assistant will do these things plus make himself available for questions and show students the amusing aspects of labs. He should also be open-minded and have a flexible personality.

"Teaching is the best thing I've done since coming to this University," said Brian Igarashi, another Physics 106 teaching assistant. It has given him the opportunity to interact with a lot of people simultaneously, in addition to making him organize his ideas and prepare them in a clear and understandable format. He feels that it is important that a good teaching assistant "be able to understand the material from the perspective of the students, not that of a Ph.D. candidate."

The ideas of students on which attributes determine a quality teaching assistant also vary. Joe Lehman, a senior in Agricultural Engineering, feels that a good teaching assistant should know the teachings and applications of his subject and be able to tell why it is important. Such a teaching assistant should also be a good communicator and relate well to the students.

Mechanical engineering junior Kevin Baxter explained that a good teaching assistant should know his subject well enough for a clear presentation in a logical manner. He feels that teaching assistants should be reasonable graders and not test the students on material that was not covered in class.

Karen Lindholm, a sophomore in electrical engineering, believes a good sense of humor helps one to be a good teaching assistant. A good teaching assistant should be prepared for any questions the students may ask and be able to answer them without going off track, in terms understandable to the students.

Freshman Brian Davison feels that there are many qualities that a good teaching assistant should possess. These include a good knowledge of the material, good speaking skills including communication and organization, and accessibility to the students. He also feels that teaching assistants for discussion sections should attend course lectures for knowledge of what is being covered.

Some safeguards are available to protect students from a less-than-ideal teaching assistant. In 100 level classes there are two instructors, both a professor and a teaching assistant, to provide two good chances for the student to find someone that he can relate to and learn from. Friedman explained this using as an example the course evaluation questionnaires given at the end of a course. In the long-hand comments, one student said that he had a terrible teacher but a good teaching assistant, while another student said just the opposite—he had a terrible teaching assistant but a good professor. Although both reacted differently to the teachers, each could adjust to one. Some teachers will get their message across better than others, and students' responses vary to different approaches. ■

# The Return of the Boomerang

Although often considered an Australian pasttime, the boomerang has gained universal appeal through its bizarre and curious flight path.

As illustrated by this sampling from Paul Sprague's collection, boomerangs do not have a singular shape, unlike many other flying objects (photo by Dave Colburn).

Deep down in a dark basement of corporate America, a crackerjack team is trying to determine the world's greatest feat of engineering. What remains unrealized is that the item they are attempting to discover is being used by people internationally and slowly gaining popularity.

The boomerang, frequently known as a "'rang" or "boom," allows individuals to get outdoors and enjoy themselves, without becoming over-exercised. 'Rangs are available in a myriad of shapes, sizes, materials, and weights for both right-handed people and southpaws.

"The returning boomerang just doesn't go straight, and therefore was not an effective weapon," metaphyses Paul Sprague, national boomerang champion, boomerang craftsman, Boomerang Club president, and University journalism student. "So Zog's kid picked it up, and said 'Hey! This is great!'" Other experts on the subject believe boomerangs developed naturally from date palm stems, because they have the characteristic shape and airfoil of a boomerang. Whatever the steps leading to its invention, the oldest 'rang found so far is over 20,000 years old.

Boomerangs have a flat bottom, and a top that is curved in the shape of a traditional airfoil. Traditional 'rangs have two arms separated by slightly over ninety degrees, although acutely angled boomerangs work superbly. Multi-bladed 'rangs come in more interesting shapes, such as Π, a tomahawk, alphabetic letters, and a pinwheel.

The best returning booms are those which are handmade, due to the fact that commercial versions never seem to work. Sprague is a co-partner of AbOriginals, a company that makes all types of booms. Building them "is mostly trial and error. You have to know the basics, like how the mass should be distributed and stuff like that, before you can make a working boomerang," he explains. Usually, booms are made of plywood or laminated strips of pine, birch, or oak, which are glued or cut into shapes and sanded down.

The process of building a boomerang is quite simple. After selecting the kind of wood to be used, the basic shape is formed. Then the airfoil is developed by rasping or sanding down the top of the boomerang. The leading edge, or the edge of the 'rang that cuts first into the air during flight, should always be the fatter part of the airfoil; the trailing edge should be sharper in comparison. This will create a curve which gives the top greater surface area than the bottom.

Once the initial airfoil is created, the builder must go out and tune the boomerang. This is done by repeatedly test-flying the 'rang, and sanding it down in the right areas until it returns. Once the 'rang flies properly, it can be finished with spray paint, enamel, boat-building epoxy, or another finisher.

Tuning a new boomerang is best understood by comprehending why a tuned one returns. There are three reasons a boomerang returns to the thrower: lift, spin, and gyroscopic precession. Although some students have obtained Ph.D.'s with theses discussing the boomerang flight path, it is not difficult to obtain a reasonable understanding of the forces in action.

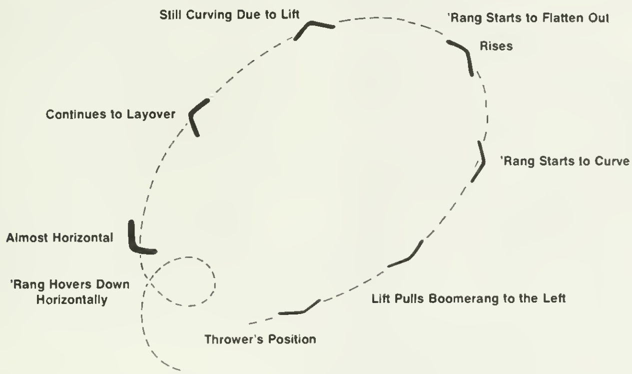
Lift is brought about by the airfoil on the boomerang arms because of the expression $\rho A v = \dot{m}$. $\dot{m}$, or mass flow, must stay constant by the laws of nature. $\rho$ is the air density, which stays the same during flight assuming the boomerang doesn't change atmospheres. $A$ is the area of the surface the air is flowing over, and $v$ is the speed of that air. The surface area of the airfoil's top, or the curved side, is greater than the flat side of the airfoil; thus the air moves slower over the top of the 'rang. Since the air flows faster over the flat side of the 'rang, the pressure is greater there than over the top, which pulls the airfoil, and subsequently the boomerang, upwards.

The second aspect of the boomerang's flight, the spin, is imparted on the



L a n g d o n   A l g e r

## Top View of a Typical Boomerang's Flight Path




Source: Paul Sprague

boom when launched and provides stability. It also starts the airfoil moving, which initiates the flight of the boomerang.

The final and most complicated part of the flight is the gyroscopic precession. This phenomenon is defined by Sprague as "the tendency of a rotor's axis to move at right angles to any perpendicular force applied to it." Thus the spin axis, which starts out parallel to the horizon, rotates clockwise in response to the lift force until the spin plane is horizontal.

The overall pattern of flight is choreographed beautifully. The 'rang is thrown vertically, and given a snap so it spins on a horizontal axis. Since the airfoil is oriented sideways, the lift is directed to the left of a right-handed thrower. This lift force is what precesses the spin axis. This process continues, with the spin sustaining it, until the axis has precessed nearly 90°. Then the boomerang is in an equilibrium state, and if the airfoil is shaped correctly, the 'rang will come directly to the thrower with an almost vertical spin axis.

The airfoil's effects can be enhanced by warping the boomerang arms. This is accomplished by steaming or heating the 'rang, and then holding the arms twisted until they cool. The effect of the warping is to accentuate the lift that the airfoil creates, or create lift in 'rangs that have no airfoils. In pinwheel 'rangs most of the lift is provided by upward warp on the ends of the pinwheel arms. In boomerangs made from cardboard, the creation of an airfoil is nearly impossible, so the lift comes only from the arms' warp.

With these many forces and warps, it would seem that operating the boomerang is a difficult skill to learn. Indeed, boomerangs can be quite temperamental; for example, the boomerang refuses to return if the wind is blowing over seven miles per hour.

When facing the wind, the boom should be thrown between 45 and 90 degrees to the right. A clockwise tilt in the spin plane can compensate for too little wind or a slightly strong wind. In the latter case, "it'll come in kinda fast usually, because the wind is blowing harder at you. But if you know what you are doing you won't hit anybody with it," claims Sprague. The secret is to snap the 'rang, imparting a high amount of spin to it. The throw rarely requires any brute force, but it does necessitate fairly strong wrists.

An ideal flight will find the boomerang making a few small circles near the thrower after its large return loop, and the 'rang will have flattened out so that it hovers overhead for a moment. Catching the 'rang takes courage, practice, and callouses, but the best way to catch it is by slapping one's hands together, trapping the boomerang between them. In the case of the pinwheel, the catch basically consists of providing any surface for the center pin to spin on. Sprague "landed a pinwheel on a judge's head one time . . . . It just settled down on [him] like a butterfly."

Such bizarre events are not unusual in the boomerang world, due to the fact that the people in 'ranging are unique and always attempting to determine new ways of throwing boomerangs. One Australian-born astronaut once decided that throwing a 'rang in deep space would result in a return time of many years: a new maximum time aloft record. A booming engineer was recently working on a 'rang that carried a timing device and a shiftable weight to achieve the maximum gain from the precession. However, the tried and true method for proficient throwing of boomerangs is still, under the advice of Sprague, to "throw them as often as possible." ■

# Forum

## The Best Years of Our Lives

This was really going to be a hectic day for me. I had an exam at eight, an interview at nine-thirty, and I had a problem set due tomorrow that I had yet to look at. All of these thoughts raced through my head as I sat in the Illini Union vending room studying for the exam. It was 3 a.m.: six hours until exam time. I just knew that things couldn't get worse.

By the time the fourth morning hour had come, my brain cells were hollering, "SLEEP!" Soon, I would listen to the call within my cranium. Soon, I would allow my head to drop to the table. I didn't even have time to think my next thought. I snored.

I felt something poking me in my side, and I woke up. It was the janitor. "Get outta here," he said. "I gotta clean up after you slobs."

I would have knocked his teeth out, but his leery smile told me that someone else had beat me to the punch. I got up and left.

When I had gotten back to my apartment, I reached into my pocket only to find a hole were my keys should have been. I didn't panic. After all, I'm an engineer, and breaking into an apartment should be an easy task for someone with my background. I was climbing the rain gutter towards my bedroom window when a voice called out from behind me, "You—come down from there."

"Officer," I said excitedly. "I'm glad to see you. I locked myself out, and. . ."

"Well, I'm glad to see you, too!" he said, as he slapped his handcuffs on my wrists.

It was eight o'clock before I convinced the police that I had lost my keys and that I was breaking into my own apartment. Eight o'clock was exam time, and I could picture the instructor walking up and down the aisles handing out the booklets. I managed to make it to the examination room by eight-thirty: that meant I had thirty minutes to finish a sixty minute exam. Great.

Nothing would discourage me. I went through that exam like nothing I had ever done before. At 8:45, I had made it to the half-way point, and I was sure that I would be able to finish. It was at that point that the instructor said, "May I have your attention, please. You will have to hand in your exams now."

The instructor went on to say that the clock in the exam room had stopped, and that it was really 9:25, not 8:45. Well, at least that explained why I had gotten so far in such short time. I handed in my exam, and I prepared to walk home. I was sure that nothing else could go wrong. And then I remembered—the 9:30 interview!

JCN, Inc. expected to interview me for an entry level engineering position within the next five minutes. I never had the chance to change into my suit, and I smelled like I had spent the night in the vending room. Thank you, Mr. Policeman. What could I do?

I resolved to do the only honorable thing. I went to speak with the representative from JCN, and I told him the whole story. He gave me a long, pensive stare, and then he spoke.

"Mr. Hightower, the story you have just told is a very interesting one. Now let me tell you something about JCN, Inc. We made fifty bezillion dollars last year. Did you hear me? Fifty bezillion dollars. We didn't get to be that large by hiring goof-offs. I'm sorry, Mr. Hightower, but JCN, Inc. does not hire engineers who make mistakes."

I would have knocked his teeth out, but his leery smile told me that someone else had beat me to the punch. I got up and left.

At this point, I was sure that negative events could never again touch my life that day. I decided that I was in need of rest.

I picked up a magazine in the hallway of the EE building and I started reading. I learned that within the next ten years, the engineering profession will be obsoleted by advances made in artificial intelligence. I was shocked! JCN, Inc. had even revealed plans for a device, known as the Wishbox™ that combined the technologies of voice recognition, artificial intelligence and speech synthesis. The person who speaks into the Wishbox™ can design virtually anything without technical expertise.

And what was to be done with the obsoleted engineers? Two plans were outlined. Some engineers would be shipped to Hollywood to star in movies about nerds. The rest would be re-trained as accountants, since engineers and accountants have similar personalities. How flattering.

I felt anger boiling within me. You mean to tell me that I've gone through four years of engineering school to become a movie star? What about those nights when my veins were filled with more caffeine than blood? What about all the parties I've missed? What about. . .

Suddenly, everything around me was out of focus, and I felt something poking me in my side. It was the janitor; I was still in the Illini Union vending room. I was dreaming.

"Get outta here," said the janitor. "I gotta clean up after you slobs."

I had no desire to knock his teeth out. Nothing had gone wrong; I had just made a temporary departure from reality. I got up, shook his hand, patted him on the back, and I left.

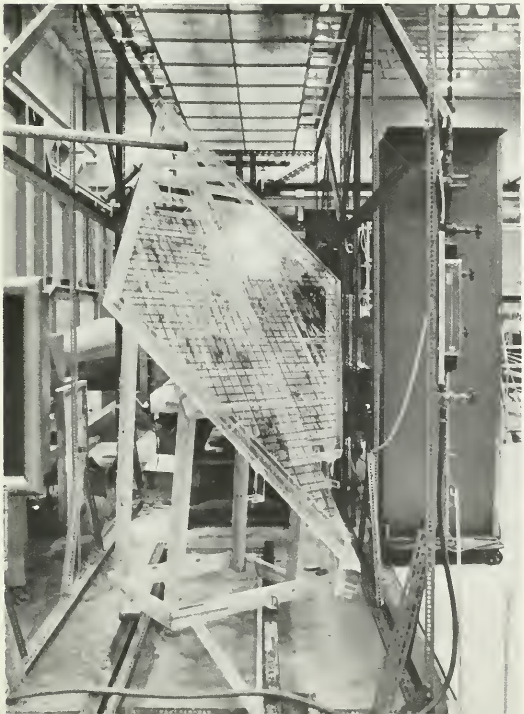
When I got back to my apartment, I reached into my pocket only to find a hole where my keys should have been. . .

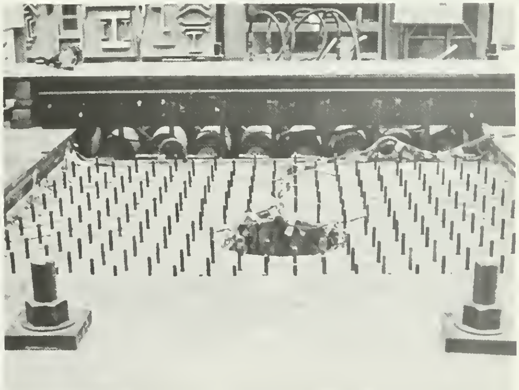
*Raymond Hightower*
*President, Association of Minority Students in Engineering*

**Water, Water Everywhere . . .**

Though we often take water for granted, civil engineers dealing in hydrosystems and environmental engineering decide on the best ways to deal with this most important substance.

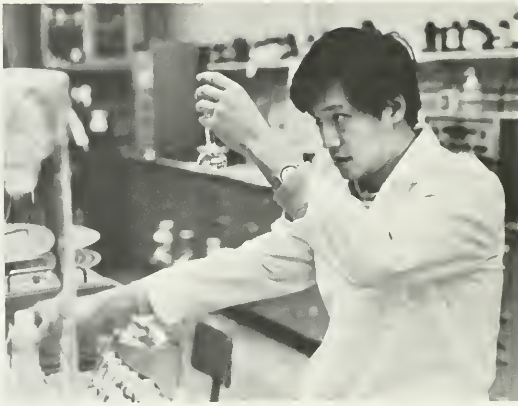
Left: Nina Johnson, a graduate student in civil engineering, measures the pH of a sample of treated wastewater. Below left: This machine tests the strengths of tunnels, including those used for the distribution of treated water and the collection of wastewater. Below: A model of the roof of One Park Place in Chicago which was used to simulate the runoff generated by a heavy rainstorm *(photos and text by Mike Brooks).*





# Fighting Water Pollution

**Engineering and Industrial development has often been criticized for its adverse effects on the local environment, but modern water treatment has applied engineering principles to obtain a cleaner and healthier ecosystem.**



**Abraham Chen, research associate for the department of Civil Engineering at the University, tests a sample of waste water treated by ozonation activated alumina adsorbtion (photo by Mike Brooks).**

With the Industrial Revolution came a great rise in the level of pollution in the world's waters. Humans have always polluted the Earth to some extent, but in this case industry dirtied the water faster than humans working without machines could ever have. Many types of water pollution exist, ranging from simple suspended solids to highly toxic materials. Fortunately, the same engineering which in part created the problem is also capable of solving it.

One group of pollutants which can easily be treated is suspended solids. Often detectable as individual particles or cloudiness in water, suspended solids are inexpensively removed. By flowing water slowly through a large tank, most large particles will settle to the bottom and form sludge by the time they reach the end of the tank. After being cleaned out of the tank, the sediment or sludge is then disposed of in a safe manner.

Any particles not removed by sedimentation can be removed by filtration. Though highly efficient, filtration incurs additional expense because the filters must stay clean. To eliminate the need to constantly change filters, the system may flush water through the filters backwards to loosen trapped particles.

Organic waste in sewage, which includes human waste, often causes more problems than simple solids. This type of pollution looks bad, smells bad, and consumes oxygen which is necessary for the survival of fish. Two commonly used biological methods which effectively eliminate most organic waste are activated sludge and fixed film.

Activated sludge uses a combination of organic consumption and sedimentation. Water passes through two tanks. The first contains microorganisms which thrive on unwanted organic materials in the water. After passing through the first tank, the water contains many suspended organisms and must undergo sedimentation in the second tank. The system then recirculates the settled organisms for reuse in the first tank.

Fixed film also uses microorganisms to consume organic waste. Instead of being circulated through the system, they grow continuously and attach themselves to surfaces in the system. Older techniques used rocks as the growing medium, but newer methods use plastic treated with carbon black to prevent deterioration in sunlight.

Two different types of organisms can be used in activated sludge and fixed film systems. The first, and more commonly used, is aerobic organisms. They consume oxygen to undergo their normal biological processes and therefore must have a sufficient supply of oxygen to be effective. Few problems are caused by this since air can simply be pumped into the water, or the water can be churned up at the surface to aerate it.

The second class of organisms is anaerobic, or non-oxygen consuming. Anaerobic processes are cheaper in the long run because it is not necessary to pump oxygen into the system, and less sludge is produced. Anaerobic organisms also produce methane gas, which can be used to run a treatment plant.

**continued on page 12**



**M i c h a e l   L i n d**

### Protecting Chips

January 7 marked the invocation of the new Chip Protection Act. Administered by the U.S. Copyright Office, the law makes it illegal to copy topographical patterns on integrated circuits introduced after July 1, 1983.

Drafted to combat widespread industry piracy and because chip development costs are incredibly high, the act makes reproduction of registered semiconductor patterns illegal for 10 years after its registration or introduction on the market, whichever comes first. It does not protect circuit designs or software, which are already protected under patent and copyright laws. Only U.S. residents or foreign nationalities whose countries have similar laws can register integrated circuits (IC's) under the act.

According to Intel General Counsel and Secretary Tom Dunlap, IC piracy has been a problem in both the United States and Japan. "The Japanese are currently drafting and reviewing a similar chip protection law, and we anticipate similar movements in other foreign countries," Dunlap explained.

To register a chip pattern, a company or individual must submit documents that uniquely describe the layout of the chip. Only original layouts can be protected. Registration must occur within two years after the chip is first introduced.

### New Leadership

University professor Charles W. Gear has been appointed head of the department of computer science. Gear will assume his position on August 21, replacing James N. Snyder, who asked to be relieved of the administrative assignment.

A professor of computer science, electrical and computer engineering, and applied mathematics, Gear has served on the faculty since 1962. He has "an internatonal reputation in the development of computational methods and software for ordinary differential equations applied to complex problems," said Mac E. Van Valkenburg, acting dean of the College.

Gear earned bachelor's and master's degrees from the University of Cambridge, England, and a master's and doctorate from Illinois. He was an engineer with International Business Machines Corporation British Laboratories from 1960 to 1962. He has served as a visiting professor at Stanford and Yale Universities and is a consultant to Argonne National Laboratory, Brookhaven National Laboratory, the Langley Research Center of the Nationnal Aeronautics and Space Administration, the National Bureau of Satndards, and the Korean Institute of Science and Technology.

"We are indeed fortunate to have Professor Gear to call upon in this period of enormous growth in the field of computer science," Van Valkenburg said. "His reputation, intelligence, and vigor will serve the department excellently as it enters this exciting era."

### Student Achievers

AT&T Information Systems Laboratories has given Achievement Awards to four undergraduate minority students.

Receiving $500 scholarships are Arthur B. Howard, a sophomore in computer science, Tracey L. Johnson, a sophomore in computer engineering, Eric J. Minor, a junior in electrical engineering, and Stephanie E. Woodson, a junior in electrical engineering.

According to Paul E. Parker, assistant dean in charge of the Minority Engineering Program, these scholarships were the first the firm has provided for minority students at Illinois.

### Christmas Toys

The College celebrated a belated Christmas this spring as it became the recipient of millions of dollars in corporate and government endowments.

The foremost gift came from the National Science Foundation to establish an advanced scientific computing center; $43 million, the largest single federal grant ever given to the University, will be used to purchase a Cray X-MP, which is currently the fastest supercomputer commercially available.

Other holiday gifts for the College include a CAD/CAM system from IBM and microwave measurement equipment from Hewlett-Packard.

The College was one of only 20 schools to receive the IBM system. It will be used for teaching and research by the departments of Aeronautical and Astronautical, Civil, General, and Mechanical and Industrial Engineering. The CPU will be housed and operated by the Computing Services Office (CSO).

The Hewlett-Packard equipment, valued at $140,000, will be used by the electrical and computer engineering department. The University was selected on the basis of the department's proposal to emphasize newer microwave design techniques in its curricula. The company also gave preference to programs "that would ensure maximum student use of the equipment, rather than emphasize research."

*Mary McDowell*

continued from page 10

Though not widely used now, the process will be more popular in ten years, explained Bruce Rittmann, an associate professor in civil engineering at the University.

Some pollutants are pathogens. These disease-causing organisms must be removed if the water is to be consumed by humans. Fortunately, most pathogens do not survive sedimentation. They also prefer environments similar to the human body and therefore do not survive long in activated sludge or fixed film methods. When removal of pathogens is especially critical, chlorine is used. However, chlorine must be used with discretion because it is harmful to fish.

Sewage is not the only contaminator of the water supply. Industrial discharges also cause pollution, mainly through toxic organic compounds, heavy metals, and lubricants.

Three different methods are used to remove toxic organic waste, and the biological processes outlined earlier for ordinary organic waste often work for the hazardous substances as well. Some materials are volatile, meaning they are easily absorbed by the air, so air blasted through the water easily removes them. Activated carbon removes many substances quite effectively, but it is not widely used because it is expensive.

Heavy metals, such as cadmium, zinc, and lead are some of the hazardous substances which need processing in industrial waste water. If only small concentrations exist in the water, sedimentation or biological processes remove the substances adequately. Both methods work because the metals tend to attach to both solids removed in sedimentation and to microorganisms. When large concentrations exist, chemicals can be added to the water to cause the metals to precipitate out. Used in conjunction with each other, these two methods remove 90 percent of the hazardous metals.

Oils and greases used for lubrication and other processes in industry form yet another waste removal problem. Oil flotation takes advantage of oil's density being less than water. In flotation, the opposite of sedimentation, oils come to the surface of a holding tank for removal. For added efficiency, the process is often followed by a filter.

Despite the attention industry receives in the area of water pollution, some forms of pollution are caused by agriculture. The runoff of plant nutrients such as nitrogen and phosphorous sometimes encourages algae growth in lakes, which adversely affects game fishing.

This nitrogen and phosphorous can be removed by various processes. Certain microorganisms thrive on nitrogen or phosphorous. Nitrogen, which often shows up in the form of ammonia, can be removed by stripping the ammonia out of the water and into the air. Phosphorous can also be precipitated with lime and aluminum.

Obviously, the technology exists to remove pollution from most controlled sources of discharge, but there is still much work to be done in other areas. One such area is the treatment of storm runoff. The same substances that pollute ordinary discharges also taint runoff, but runoff is more difficult to treat because it comes in large quantities for short periods of time. Large retention basins are needed to hold the water for treatment, making treatment a problem for many municipalities.

Another form of water pollution which has received much public attention lately comes from landfill runoff. The methods discussed so far remove waste from controlled discharges, but landfills leach substances uncontrollably. Drains built under landfills have proven workable for new landfill sites, but no solutions have been developed yet for existing sites. According to Rittmann, controlling waste flow from landfill sites should be one of the most active areas in environmental engineering.

The future appears promising for the cleanliness of water, and Rittmann believes that the quality of the America's water supply will continue to improve. However, engineers must continue to address their responsibility for the environment with new solutions to the water problems. ■

From page 3

### Tech Teasers Answers

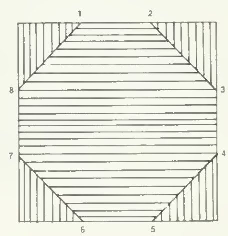
**1.** The one with the greatest "mew" ($\mu$ = coefficient of friction).

**2.** \$3,000.

**3.** 72.

**4.** Converting the fortune to a base 7 representation shows that: 1,000,000 = 11,333,311. Therefore, the digits of the number yield the following distribution: 1 received \$1; 1 received \$7; 3 received \$49; 3 received \$343; 3 received \$2401; 3 received \$16,807; 1 received \$117,649; and 1 received \$823,543.

**5.**



### The Lighter Side

The world's shortest light pulse was generated by IBM scientists at the Yorktown Heights, New York facility. A pulse of 12 femtoseconds, or 12 quadrillionths of a second, was made using a laser and a light compressor.

The pulses can serve as a strobelight to slow or freeze the apparent motion of molecules, atoms, and electrons so that their extremely rapid interactions can be studied in detail. This achievement could help researchers better understand some fundamental physical processes important to the development of the ultra-fast computer components in the future.

A femtosecond (fs) is almost unimaginably brief. There are as many of them in one second as there are seconds in 30 million years. In two seconds, light travels from the earth past the moon. In 12 fs, it moves only five microns, roughly one-tenth the width of a human hair.

The light compressor flashes 800 12-fs pulses per second, made by alternately stretching and compressing laser light. In the light compressor, 100-fs pulses from a dye laser are sent through the minute core of an optical fiber which is less than two ten-thousandths of an inch wide.

Interactions between the laser light and the fiber increase the light's bandwidth and separate the colors so that the longer, "redder" wavelengths are ahead of the shorter "bluer" wavelengths. This timing change is known as chirping.

After the pulse leaves the fiber, it bounces between two diffraction gratings which scatter colors in different directions. In this pair of devices, the front and rear portions of the chirped pulse act like race cars moving at the same speed but on different tracks. The red car starts in front, but the blue car takes the inside shorter lane. In the end, the two arrive together. This results in a compressed pulse that is shorter and more intense than the initial one.

This discovery will help to understand the chemical and physical processes that occur too rapidly to be studied in great detail. Instead of only knowing what the initial reactants are and what the product is, scientists will be able to learn about the interim processes to advance their knowledge rapid reactions.

### Waste Not, Want Not

A rotary reactor and a newly developed Environmental Vault, patented by Rollins Environmental Services, may provide a solution to the problem of hazardous waste storage.

The vault, an above-ground structure, covers about an acre and a half and is 20 to 25 feet tall in typical installations. It protects the waste from both precipitation and ground and surface water. Meanwhile, polymer liners and porous layers protect the ground from wastes and leachate. The vault is equipped with a monitoring system, and the top has a storm water runoff system.

The vault/reactor system provides several advantages over traditional methods of waste containment. Since it is completely above ground, any leakage or deterioration can be quickly detected and repaired. The system is not dependent on the geology or hydrology of the location, and all the monitoring and leachate systems are gravity-driven and independent of mechanical devices.

### Speech Clarity

Bell Laboratories has developed a new speech synthesizer which can code and store one second's worth of speech with only 9,600 bits of memory: one third that of other synthesizers. In addition, the speech quality is considerably improved over the speech currently emitted from talking cars, toys, and cameras.

The basis of the new synthesizer is the Multi-Pulse Linear Predictive Coding (MPLPC) algorithm, developed by AT&T for digitally coding and decoding speech patterns. This program permits the synthesizer to compose high quality speech with fewer bits of information than similar speech simulators require. By cutting down on the amount of memory required, the algorithm reduces the cost of synthesizing speech.

The synthesizer consists of two microchips, both developed by AT&T. The MPLPC algorithm is coded into one of the chips: a digital signal processsor that executes 2,500,000 instructions per second. This converts the stored digits back into high quality speech. The second chip is a dual-port Random Access Memory (RAM). This chip can be accessed simultaneously by both the signal processor and a host computer or controller. The host computer stores the coded messages for the synthesizer to process, transferring the appropriate bits of information to the dual-port memory as required. The bits are then retrieved from the RAM by the digital signal processor and turned into spoken sentences.

Possible applications for this synthesizer include uses in the telephone network for announcing changed numbers and in easing information exchanges with computers via telephone.

*Mary McDowell*

# The Reflective Vision

*A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.*

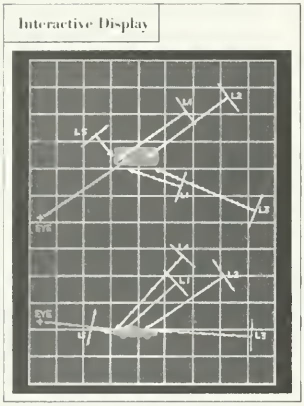
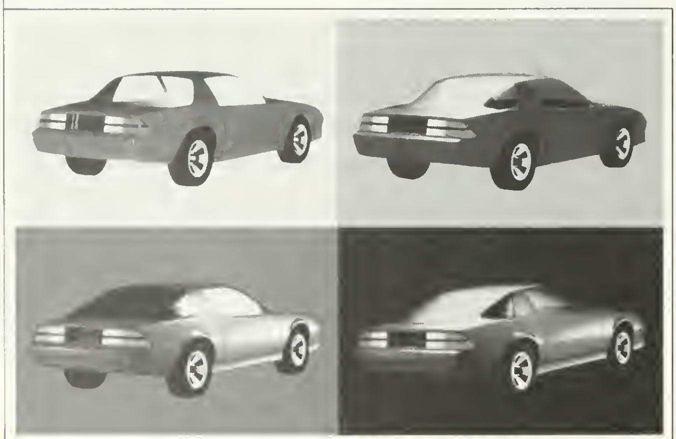



*Figure 1: Computer display of plan view (upper) and side elevation (lower), indicating automobile location, lighting selections (L1-L5), and viewing position (EYE).*

*Figure 2: Four Autocolor images, showing the same view of an automobile as background and lighting change.*



WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

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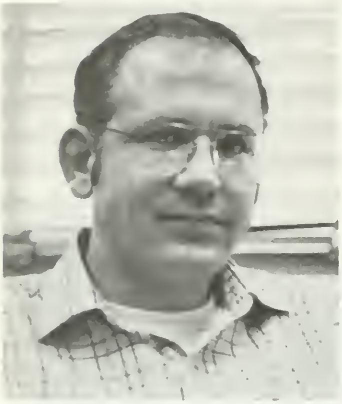
## THE MAN BEHIND THE WORK

David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.



**Peter W. Sauer,** a native of Minnesota, received his undergraduate training in electrical engineering from the University of Missouri. After serving in the Air Force for four years, he attended Purdue University and obtained his master's and Ph.D. with a concentration in electrical power systems.

Sauer has served as a professor in the College since 1977 and currently teaches EE 333, Electronic Machines Lab, and EE 331, Introduction to Electrical Power Engineering.

Though Sauer enjoys teaching, he prefers to devote an equal amount of his time to research. Presently Sauer is studying the effects of electro-mechanical oscillations in generators due to outside disturbances. Also called "security assessment" or "contingency analysis," this branch of research "attempts to maintain the integrity of power systems."

With the help of computers and a great deal of mathematical calculation, Sauer is also researching theories of time-scale modeling, dealing with the interaction of electronic and mechanical devices. In yet another part of his research, Sauer is investigating the propagation of transients through power supplies and into computer systems.

Sauer takes the many facets of his position as professor, researcher, advisor, and teacher seriously. To Sauer, the combination of these demanding roles and the many responsibilities they entail aren't always properly appreciated.

Apart from his annual fishing trip, Sauer spends his spare time with his two children and is currently refinishing his home.

*Carolyn A. Keen*

**Clark W. Bullard**, director of the University's Office of Energy Research, has done research into the effects of acid rain legislation on public utilities.

One bill being considered by Congress would set a maximum statewide pollutant emission standard, while another would simply call for installation of pollution control devices on the nation's fifty largest pollutant emitters. The first would promote the use of low sulfur content coal in utilities as a least-cost strategy, while the second would require pollution control devices on targeted generating plants.

These bills raise the question of whether it would be most economically feasible for utilities to switch to low sulfur content western coal, to install scrubbers, or to simply retire "problem" plants early. Bullard has developed computer models which simulate these alternatives by accounting for changes in electricity demand and the costs of energy sources.

From test runs of the models, Bullard found that Illinois' high sulfur coal industry would be hurt if utilities followed the least-cost strategy of buying low sulfur content Western coal. However, that industry would not be hit as hard if scrubbers are installed or if the early retirement option is selected.

Bullard explained that this research project was data-constrained due to the variety of sources, unlike many University research projects where data is more easily collected through controlled experiments. His research is aimed at identifying, through error and sensitivity analyses, the types of multi-year, capital intensive data collection efforts needed to resolve uncertainties associated with acid emission reduction strategies.

*Mike Schneider*

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